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# 18/30 GHz FIXED COMMUNICATIONS SYSTEM SERVICE DEMAND ASSESSMENT

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
NASA LEWIS RESEARCH CENTER

NAS-3-21359



VOLUME I — EXECUTIVE SUMMARY



# **18/30 GHz FIXED COMMUNICATIONS SYSTEM SERVICE DEMAND ASSESSMENT**

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**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
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**VOLUME I — EXECUTIVE SUMMARY**

## TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
I	Introduction	2
A.	Objectives	2
B.	Study Background	2
II	Overall Methodology/Results	3
A.	Literature Survey	3
B.	Telecommunications Service Forecasts	3
C.	Traffic Distribution Profiles	9
D.	User Demand	11
E.	Metropolitan Area Study	14
F.	Satellite Service Demand	15
G.	Satellite Market Forecasts	21
H.	C and Ku Band Satellite Saturation	26
III	General Study Observations	26
IV	Study Result Considerations	28

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## EXECUTIVE SUMMARY

### I. INTRODUCTION

#### A. OBJECTIVES

The 18/30 GHz Communications Systems Service Demand Assessment for 1980-2000 is a NASA sponsored market analysis study of the total demand for telecommunications services. The study also concerned itself with the identification and quantification of services which may be suitable for 18/30 GHz satellite systems.

The primary objectives of the study involved:

- quantification of current demand for voice, video and data services
- projection of future demand over the 1980-2000 time period
- identification of current and potential service users
- evaluation of a typical U.S. city's traffic demand
- telecommunications traffic patterns
- comparison of the costs of competing transmission systems

These market study objectives were interrelated in a manner to aid in the segregation of traffic suitable for satellite transmission and separation of that demand into C, Ku band and 18/30 GHz satellite systems.

#### B. STUDY BACKGROUND

As a result of Western Union's response to a late 1977 Request For Proposal, Western Union was awarded a nine month study contract in June 1978.

In addition to Western Union, NASA awarded a second market study contract to ITT-USTT, plus 18/30 GHz system study contracts to Ford Aerospace and Hughes Aircraft. Although all four study efforts were performed simultaneously, Western Union held review meetings with both systems contractors to exchange information used in system and market modelling.

The product of this study effort performed by Western Union is provided in the Final Study Report. NASA is conducting these studies as the first phase of a program to promote the commercial applications of the 18/30 GHz band.

A five year program has been structured to identify and develop critical technologies to the point of commercial acceptance. The initial phase of this effort consists of assessment and concept definition studies to characterize the market for communications services and to identify viable systems.

## II. OVERALL METHODOLOGY/RESULTS

A total of fourteen major study tasks and subtasks were undertaken in the 18/30 GHz Communications System Service Demand Assessment. All tasks were interrelated in some way and yielded valuable information utilized in subsequent tasks. The flow of the tasks and their interrelationship is displayed in Figure 1.

### A. LITERATURE SURVEY

A comprehensive review of over 250 telecommunications publications and reports was conducted. From each document a brief synopsis was extracted which characterized the relevant data dealing with market trends and forecasts. In addition, visits were made to such key government agencies as the Federal Communications Commission, National Telecommunications Information Administration and Commerce Department. Contact was made with relevant industry trade associations such as American Bankers Association, Public Service Satellite Consortium and American Telephone Association to discuss trends in communications use. A number of the more prominent market research consulting firms were contacted to discuss their forecasts for communications services and equipments. Finally, discussions were held with a number of large universities involved in communications and with major corporate communications managers.

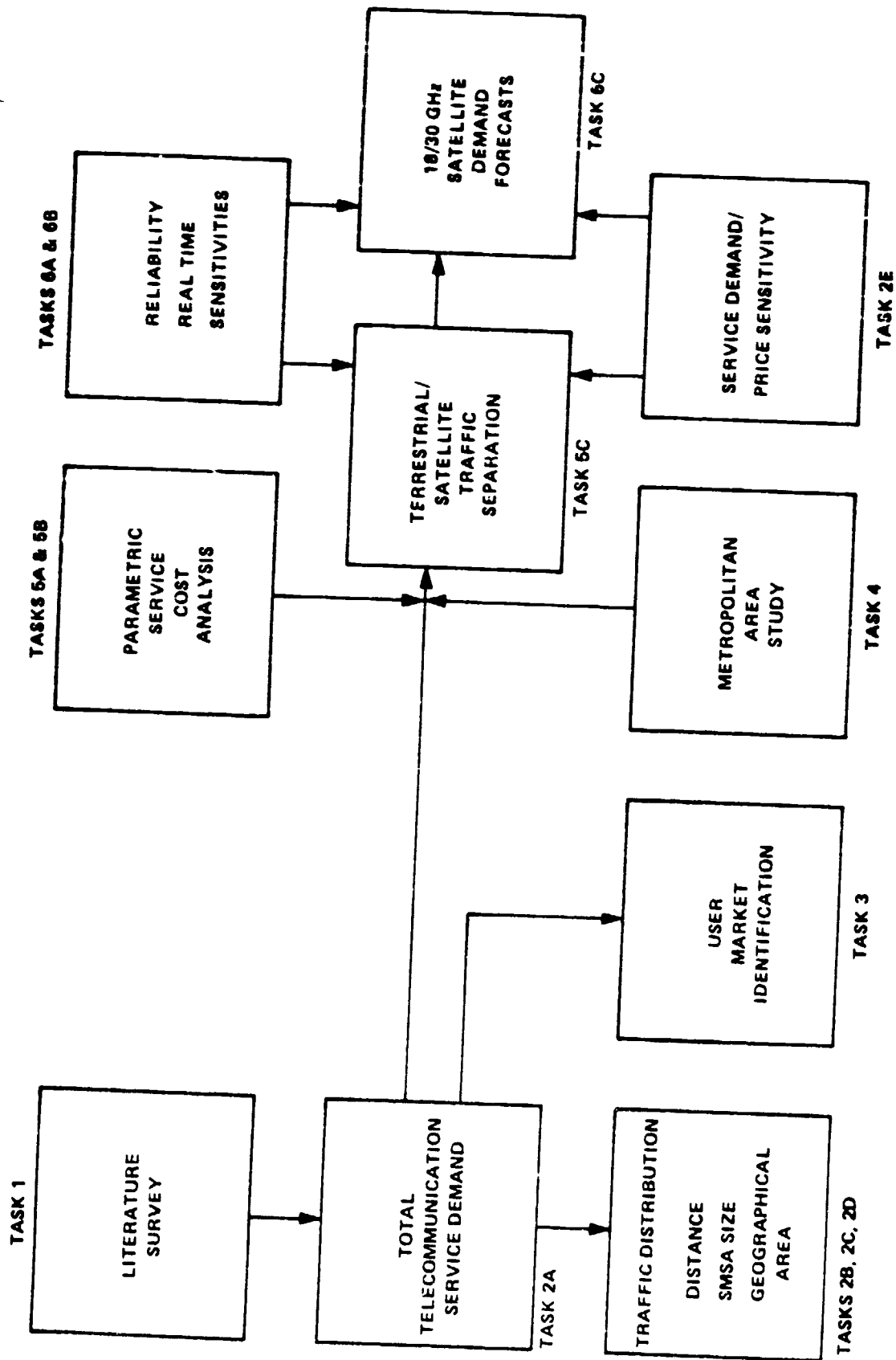
The result of these extensive investigative efforts was twofold: first, a good deal of the quantitative information formed a valuable input to determining current service demand, and second, it provided helpful information in identifying existing and anticipated services and applications.

The product of the literature review also yielded an annotated bibliography.

### B. TELECOMMUNICATIONS SERVICE FORECASTS

A total of 21 data services, 5 voice services and 5 video services were analyzed and their current traffic volume determined for the three key time periods - 1980-1990-2000. The three basic services' forecasts of traffic have been quantified in the appropriate units of measure.

- Voice - half circuits (thousands)
- Video - wideband (36 MHz) channels
- Data - terabits ( $10^{12}$ ) per year



**STUDY TASK RELATIONSHIPS**

FIGURE 1

For each market forecast, three ranges of traffic projections have been developed: high level, expected case, low level. Only the expected case forecasts are presented in the tables and figures below.

The market definition phase was the process of projecting demand communications services by identifying and categorizing the multitude of present and future services and applications. Over 150 candidate applications were identified as a result of the literature survey. Applications with similar service features were combined together, and other applications with insufficient demand were eliminated. The result was a total of 31 communications services and applications for the voice, video and data categories (shown in Table 1). For each, an application description and market scenario was prepared to eliminate duplicate demand between service applications.

The initial long term communications services traffic forecast, called the baseline market demand, was prepared and contained a forecast for each of the 31 applications over the 1980-2000 time period. Computer modeling was used to maintain the large database and reflect the projected average annual growth rates. The baseline forecast was predicated on lower risk, more predictable events and a "normal" level of growth.

The baseline market forecast indicates some variances in the average annual growth rates of service categories. Table 2 shows that data traffic is projected to grow the fastest of the three services, at an annual rate of around 16%, and the fastest growing data application will be data transmission (i.e., data entry, batch, remote job entry, packet switching, etc.). Voice services are projected to have an average growth rate of about 10% per year and reflect Message Toll Service (MTS) usage converted to demand expressed in half voice circuits.

Table 2 - Baseline Market Forecast

<u>Service</u>	<u>Units of Volume</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>
Voice	Half Circuits (Thousands)	3063	7661	19008
Video	Wideband Channels	176	267	341
Data	Terabits/Year	1670	8883	34813

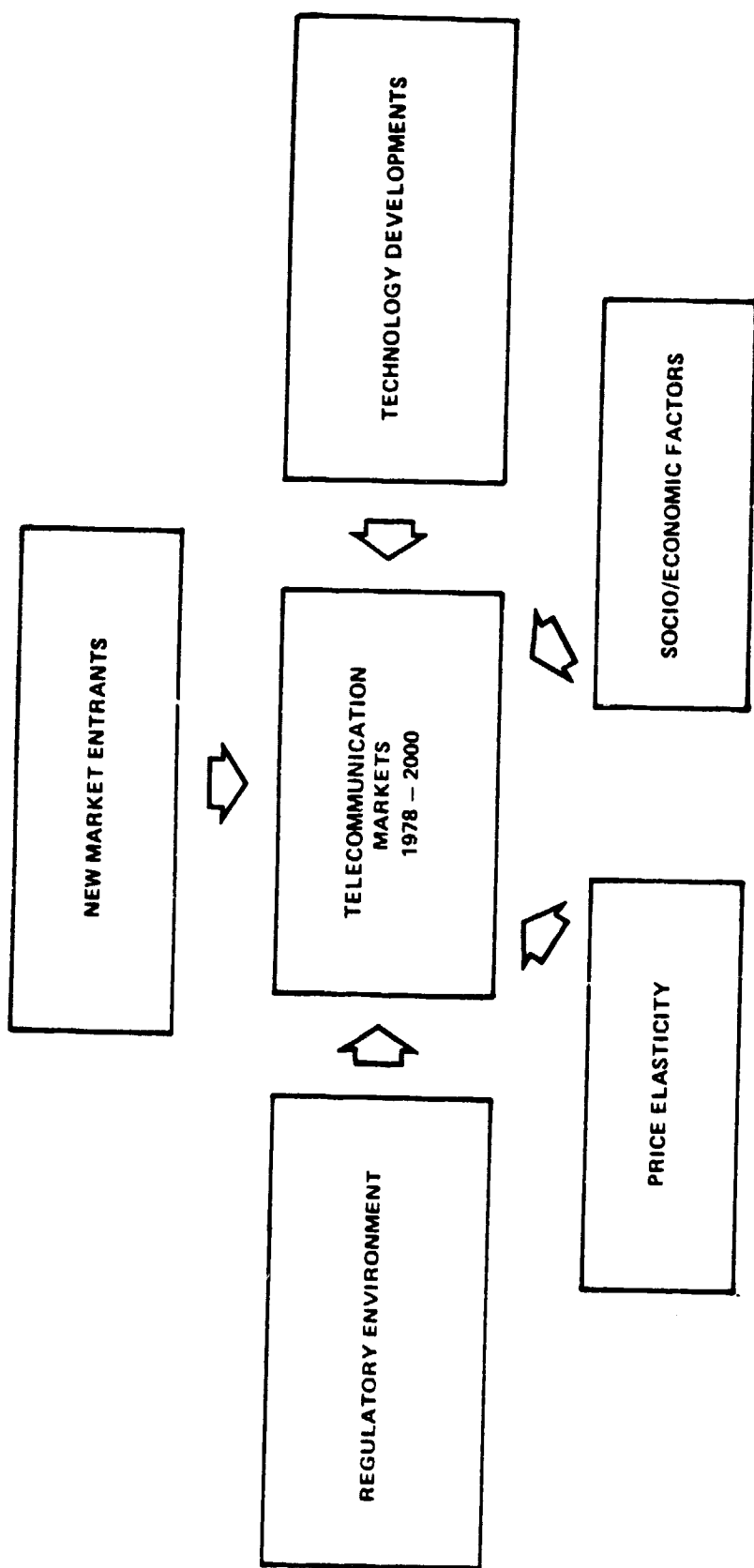
The baseline forecast was modified by market determinant factors (Figure 2) to reflect higher risk events. These factors were organized to quantify effects of these events by assessing their probability of occurrence, time, and potential impact, with both high and low ranges of impact. An example would be the widespread installation of fiber optics for intercity transmission or the rapid rise in energy costs.



DATA SERVICE CATEGORY (21)	
<ul style="list-style-type: none"> <li>● DATA TRANSMISSION APPLICATIONS (8) EG. <ul style="list-style-type: none"> <li>– DATA TRANSFER</li> <li>– BATCH PROCESSING</li> <li>– DATA ENTRY</li> </ul> </li> <li>● EFTS/POS APPLICATIONS (2)</li> </ul>	<ul style="list-style-type: none"> <li>● ELECTRONIC MAIL APPLICATIONS (8) EG. <ul style="list-style-type: none"> <li>– ADMINISTRATIVE MESSAGE TRAFFIC <ul style="list-style-type: none"> <li>– TWX &amp; TELEX</li> <li>– MAILGRAM AND TELEGRAM</li> </ul> </li> </ul> </li> <li>● MISCELLANEOUS APPLICATIONS (3)</li> </ul>
VOICE SERVICES (5)	
<ul style="list-style-type: none"> <li>● PRIVATE LINE</li> <li>● MTS (PUBLIC)</li> <li>● MTS (BUSINESS)</li> <li>● RADIO PROGRAM TRANSMISSION</li> <li>● MOBILE RADIO TELEPHONE</li> </ul>	<b>VIDEO SERVICE (5)</b> <ul style="list-style-type: none"> <li>● NETWORK VIDEO</li> <li>● OCCASIONAL VIDEO</li> <li>● CATV DISTRIBUTION</li> <li>● TELECONFERENCING</li> <li>● INTERACTIVE HOME VIDEO</li> </ul>

## EXISTING & ANTICIPATED SERVICES & APPLICATIONS

TABLE 1



## MARKET DETERMINANT FACTORS

FIGURE 2

A second technique employed at this point was the integration of cross impact relationships. Cross impact modelling was used to transform perceptions and assumptions into quantitative analysis and aid in eliminating duplicate demand forecasts. An example of this is the growth of communicating word processors at the expense of facsimile equipment.

The integration and manipulation of all these market adjustment factors on each service application was completed with aid of computer modeling. A sufficient number of simulations were run to generate a distribution of scenarios from which high, low and expected traffic demand forecasts could be selected. The expected traffic forecast is shown in Table 3.

Table 3 - Impacted Baseline Forecast

<u>Services</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>
Voice (half circuits - Thousands)	3068	8050	20371
Video (wideband channels)	176	294	458
Data (terabits/year)	1678	10559	42834

Data services annual growth rate increased to 17.5% per year versus 16%; voice services growth added about 1.3 million half voice circuits by year 2000; the video services forecast increased 117 wideband channels by year 2000, and its growth rate averaged near 5% versus the 3.5% in the baseline.

The last and more important market projection, called the net long haul traffic forecast, represented the impacted baseline traffic modified by certain market constraints. These constraints involve the removal of:

- traffic which flows within a Standard Metropolitan Statistical Area (SMSA), the basic geographic boundaries of a U.S. city used in this study,
- inter-SMSA traffic of less than 40 miles in distance, considered to be short haul,
- traffic going to remote locations outside the 275 SMSA's which make up the geographical coverage in this study. This covers all major U.S. cities and contains 72% of U.S. population.

The resulting net long haul traffic forecast shown in Table 4 was the basis for all traffic distribution and traffic separation analyses which follow.

Table 4 - Net Long Haul Traffic Forecast

<u>Services</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>
Voice (half circuits - Thousands)	2095	5320	13805
Video (wideband channels)	176	293	458
Data (terabits/year)	1078	6957	27554

Within the above service forecasts, certain individual applications are projected to grow at faster rates than the service as a whole. In the voice services category, the MTS-Business application is projected to grow fastest achieving a 37% share of the voice group by year 2000.

Data transmission application will remain the dominant segment of the data services category throughout the 20 years. Video teleconferencing is projected to grow from a 13% share of video services in 1980 to more than 50% of all video traffic by year 2000.

#### C. TRAFFIC DISTRIBUTION PROFILES

The characteristics of traffic distribution were determined by utilizing a computer based Market Distribution Model to determine market values for distinct services. The model was especially useful in developing the distance distribution, geographical distribution and SMSA population size distribution analyses.

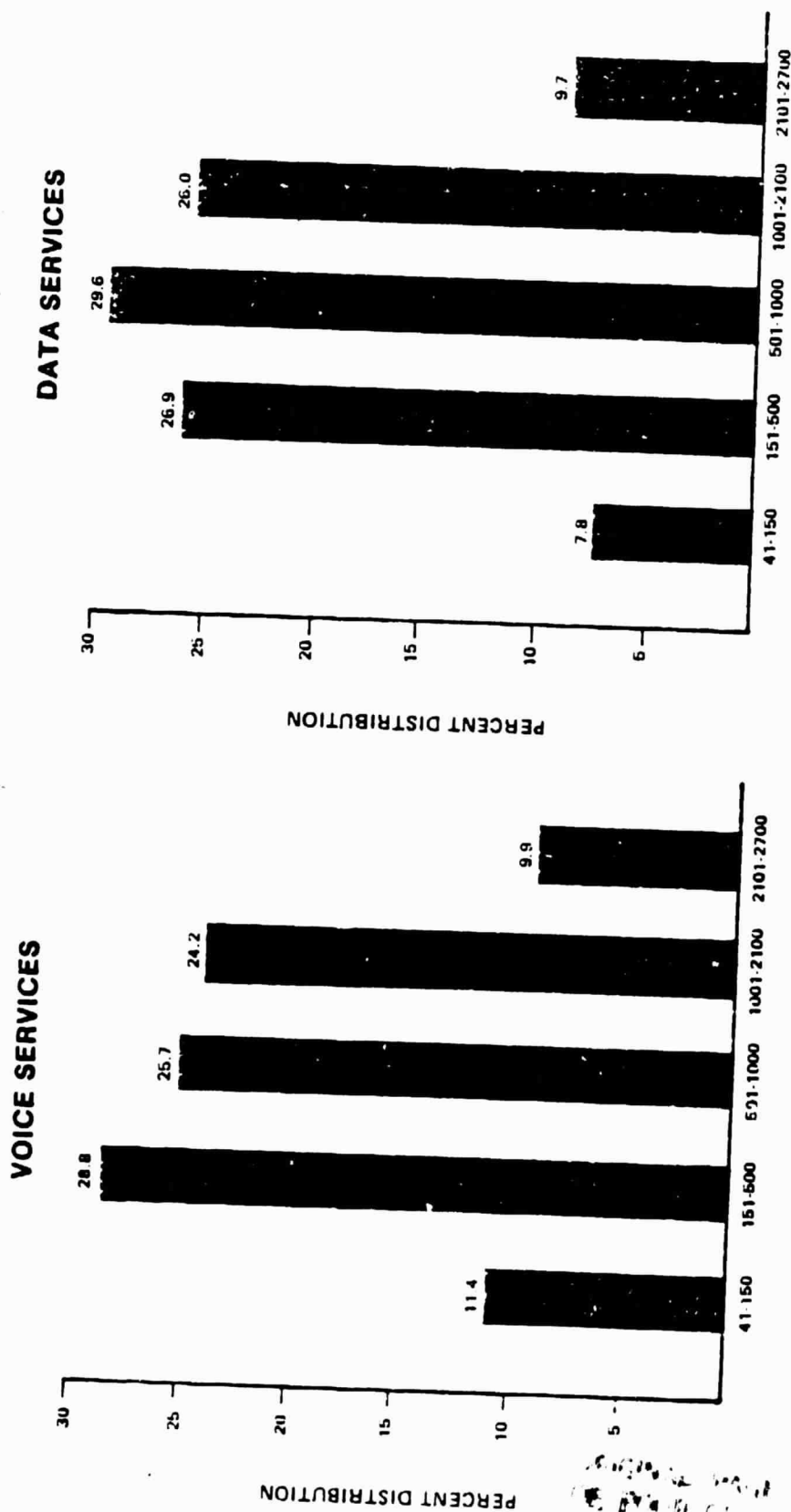
##### C.1 Distance Distribution of Traffic

Voice and data traffic volume was estimated as a function of distance. Traffic patterns associated with each service category were analyzed. The Market Distribution Model was used to distribute nationwide service forecasts to individual routes, accumulate market potential for specific routes and generate traffic distribution profiles as a function of distance by SMSA pairs. Communications traffic was classified into six mileage bands ranging between 40 to 2700 miles. Traffic less than 40 miles was dropped from consideration due to its short haul nature.

The traffic distance distribution shown in Figure 3 identifies the estimated proportion of voice and data services traffic found in six broad mileage ranges which contain over 37,000 route pairs. The heavy traffic concentration in the 150-1000 mile range is explained by the concentration of businesses in the North Central and North East industrial corridors.

##### C.2 Traffic as a Function of Metropolitan Area Size

The relationship of traffic demand to Standard Metropolitan Statistical Area (SMSA) size was estimated by classifying the 275 SMSA universe



## TRAFFIC DEMAND/DISTANCE DISTRIBUTION 1990

FIGURE 3

into five population categories. The total study coverage provided for 72.4% of the U.S. population and included all cities with a population of at least 58,000. The computer model was used in performing this aggregation of traffic by SMSA size.

The proportion of market demand for voice and data services is shown in Figure 4. The heaviest concentration is in the 1.5 million and 4 million + population categories. These two categories represent only 20 SMSA's but contain about 48% of the total SMSA population.

### C.3 Geographical Distribution

Utilizing the nine standard geographical regions, the geographical distribution of U.S. traffic was determined.

#### U.S. GEOGRAPHICAL REGIONS

- |                      |                            |
|----------------------|----------------------------|
| - New England        | - East South Central       |
| - Middle Atlantic    | - West South Central       |
| - South Atlantic     | - Mountain                 |
| - East North Central | - Pacific (excludes Hawaii |
| - West North Central | and Alaska)                |

Each of the 275 SMSA's was classified into geographical regions, with the aid of the Market Distribution Model. The total traffic forecast by service was distributed into each region.

Figure 5 shows the service geographical distribution patterns for year 1990. Significant shifts toward increased traffic are foreseen for the regions comprising the "Sunbelt" South Atlantic, West South Central and lower parts of the Mountain and Pacific regions.

### D. USER DEMAND FOR TELECOMMUNICATIONS

Forecasts of traffic demand for each service were developed for the four user categories:

Business: All business corporations

Government: Federal, State and Local

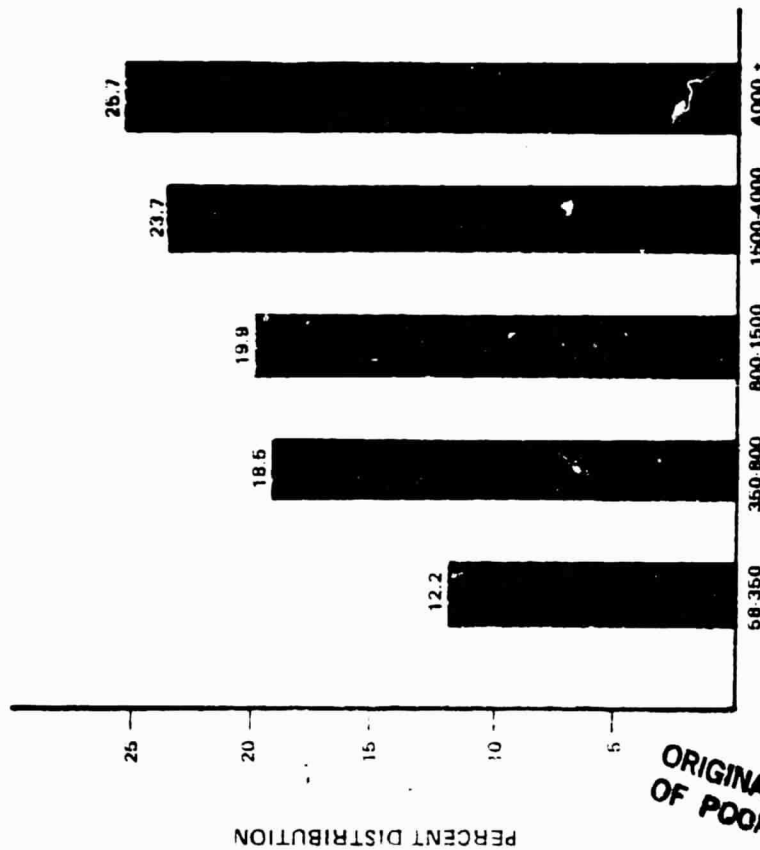
Institutions: Hospitals, schools, labor unions, and other membership organizations

Private: All U.S. Households

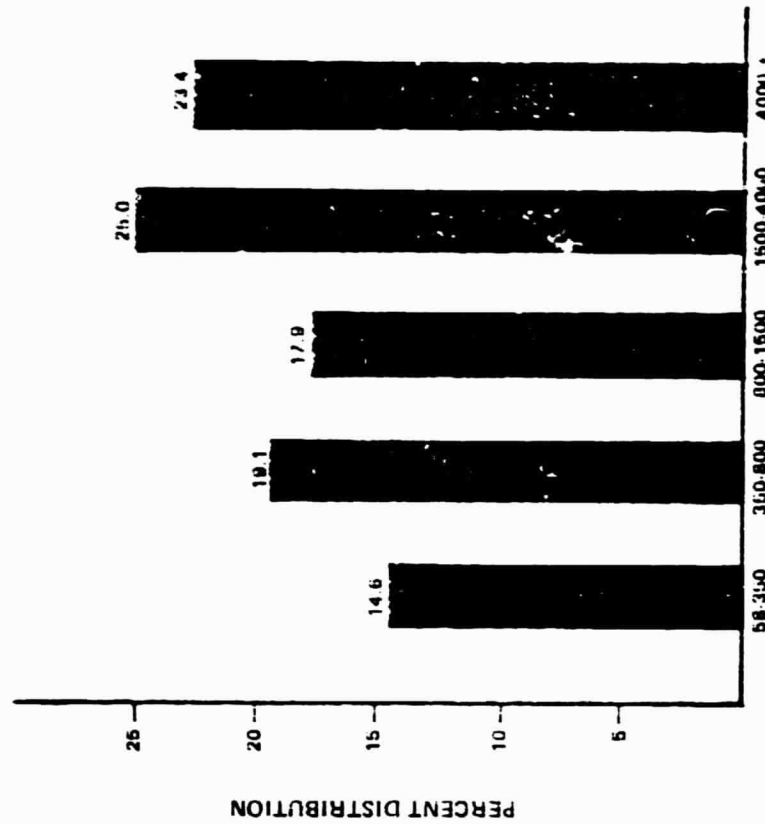
The user group forecasts required evaluating pertinent source material on their telecommunications needs and expenditures. A quintile

1990

# VOICE SERVICES



# DATA SERVICES

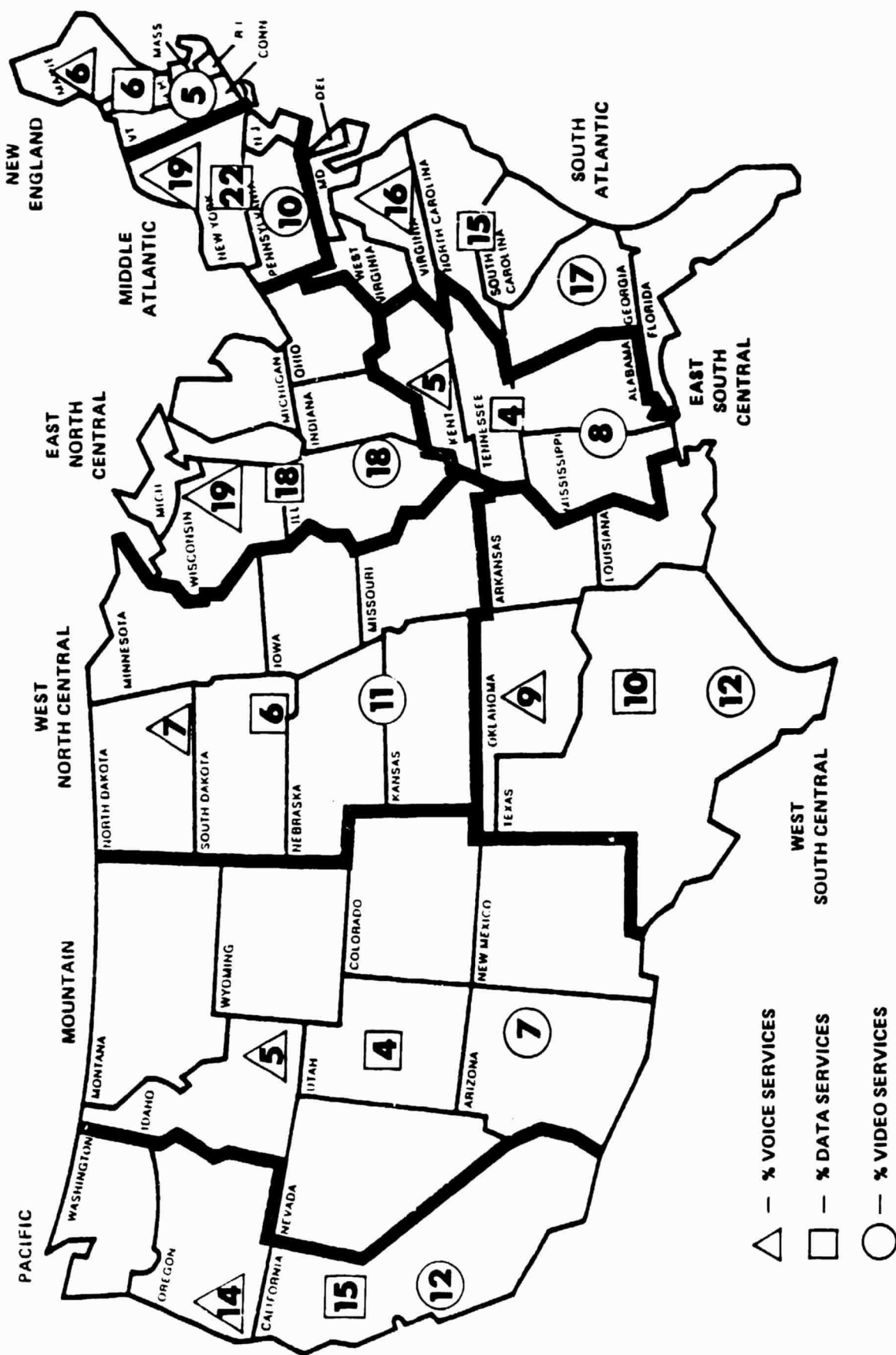


## TRAFFIC DEMAND/POPULATION DENSITY

POPULATION CATEGORY (000'S)

FIGURE 4

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**GEOGRAPHICAL DISTRIBUTION OF TRAFFIC BY REGION**

**1990**

**FIGURE 5**



distribution of population and the telecommunications demand for each user category was developed to identify "typical" users. A survey of the selected typical user was conducted to estimate their demand for each service type. Furthermore, users demand for each service was distributed among the nine U.S. geographical regions.

The steady growth in long distance phone calls is shown in Table 5 to be heavily supported by business and private users. Government and institutions are fairly mature user categories for long haul voice communications.

Business is expected to be the dominant user group for data communications, representing 82% of total data traffic. The demand for data communications by business will grow at an average annual rate of 18% over the next two decades.

Video services demand will also be dominated by business users, representing about three quarters of total video services. Innovative video-conferencing applications will also be utilized by government and institutions to reduce travel time and costs.

Table 5 - Net Long Haul Traffic Volumes  
1990

User Category	Voice		Data		Video	
	Circuits x 1000	%	Terabits/Yr.	%	Channels	%
Business	2841	53.4	5715	82.1	218	74.6
Government	575	10.8	1111	16.0	21	7.0
Institutions	133	2.5	91	1.3	54	18.4
Private	<u>1771</u>	<u>33.3</u>	<u>40</u>	<u>.6</u>	-	-
Total	<u>5320</u>	<u>100.0</u>	<u>6957</u>	<u>100.0</u>	<u>293</u>	<u>100.0</u>

#### E. METROPOLITAN AREA STUDY

The metropolitan area study involved analyzing demand for voice, data and video services for a representative metro city. The selection of the candidate city, Phoenix, Arizona, came about as a result of an in-depth evaluation of six cities of comparable size.

Primary market research efforts involved conducting personal interviews of users. These users came from a number of industry categories:

manufacturing, government, banking, newspapers and others which operate within the Phoenix area. In addition, discussions were held with Mountain Bell Telephone Company, the Phoenix Chamber of Commerce and Western Telecommunications Inc., a video common carrier heavily represented in that city.

Secondary market research was developed by a review of local government and business literature and statistics plus obtaining private and common carrier microwave maps for the area. Data on the distribution of terminals and computers by sections of the metro Phoenix area was also obtained.

An analysis of the traffic flow and data obtained was made with the aid of a computer model. Traffic demand, both current and projected, was distributed by zip code locations to show telecommunications activity by city section. In addition, traffic flows to other U.S. cities was obtained and plotted on maps.

Figure 6 shows the distribution of Phoenix intercity traffic based on the number of times a city was mentioned by a survey respondent. Los Angeles has the highest number of mentions because of its proximity to Phoenix and close business ties.

There exists a fairly heavy concentration of transmission facilities across the Phoenix metro area. Figure 7 identifies the common carrier microwave and earth station locations in Phoenix.

A composite of all traffic indicators of local Phoenix traffic is displayed in Figure 8. The composite profile reflects locations of user terminals, computers, Telex/TWX stations, private line terminations and local telco offices.

Among the conclusions drawn from the area study are that communication expenditures, especially for data transmission, are expected to grow an average of 15-20% over the next five years. Use of high data speeds, dedicated earth stations and electronic mail services are all expected to expand significantly during the next decade.

#### F. SATELLITE SERVICE DEMAND

Several significant tasks were involved in the separation of the satellite services demand from the total telecommunications service forecast. These included analysis of service demand as a function of reliability, price elasticity and real time delivery as well as projected satellite service costs.

##### F.1 Service Demand as a Function of Reliability

The primary objective was to segregate service demand into two service groups: those with high reliability requirements and low reliability requirements. Consideration was made for reliability of service provided by the common carrier, that is between, but not including, the user's premises equipment. Three base reliability levels or ranges were defined.

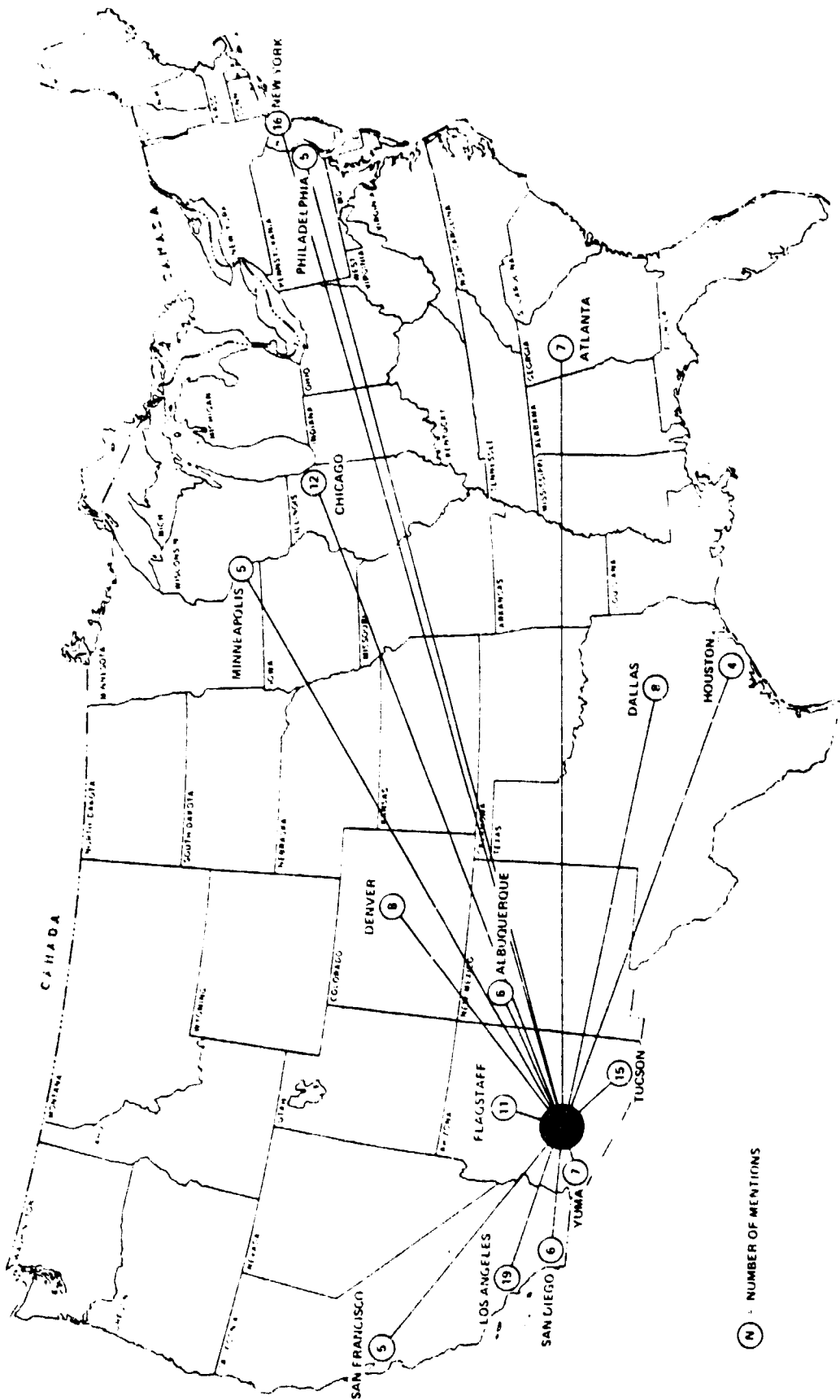


FIGURE 6 PHOENIX INTERCITY TRAFFIC

(N) = NUMBER OF MENTIONS



# LOCAL PHOENIX TRAFFIC COMPOSITE OF TRAFFIC INDICATORS

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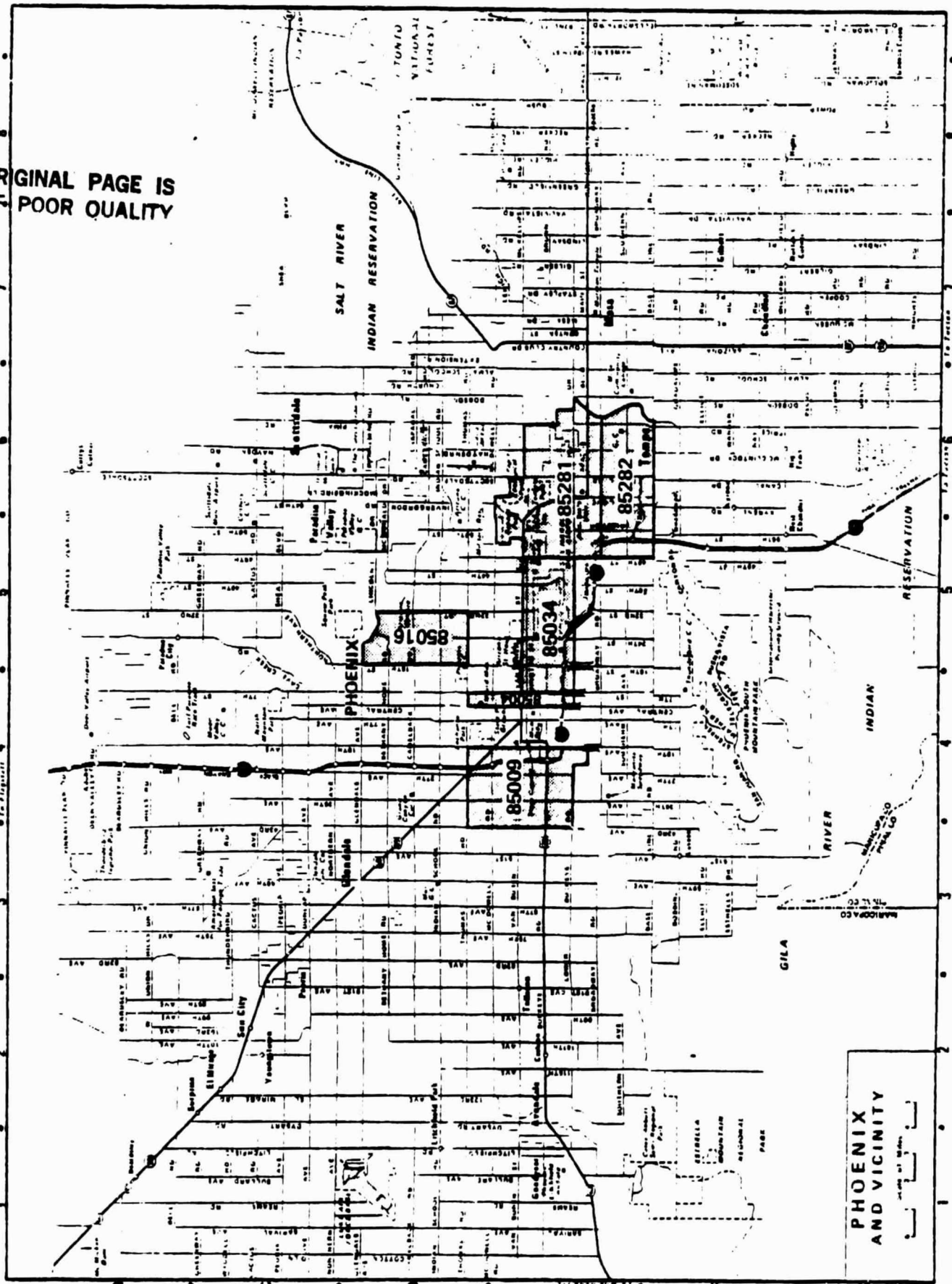


FIGURE 8

	<u>Reliability (%)</u>
High Reliability	99.9 to 99.99
Medium Reliability	99.0 to 99.90
Low Reliability	95.0 to 99.00

For each application, a list of characteristics of demand at acceptable reliability levels was prepared. The product of this research was an estimation of the reliability level requirements by service over the 1980-2000 period. Table 6 displays the distribution of service demand over three levels of reliability, as a percent of total demand.

Table 6 - Service Demand as a Function of Reliability  
(Percent of Total)

1990

<u>Reliability Level</u>	<u>Voice (%)</u>	<u>Data (%)</u>	<u>Video (%)</u>
High	66	42	86
Interruption Tolerant (Medium)	34	31	11
Outage Tolerant (Low)	<u>-</u>	<u>27</u>	<u>3</u>
Total	100	100	100

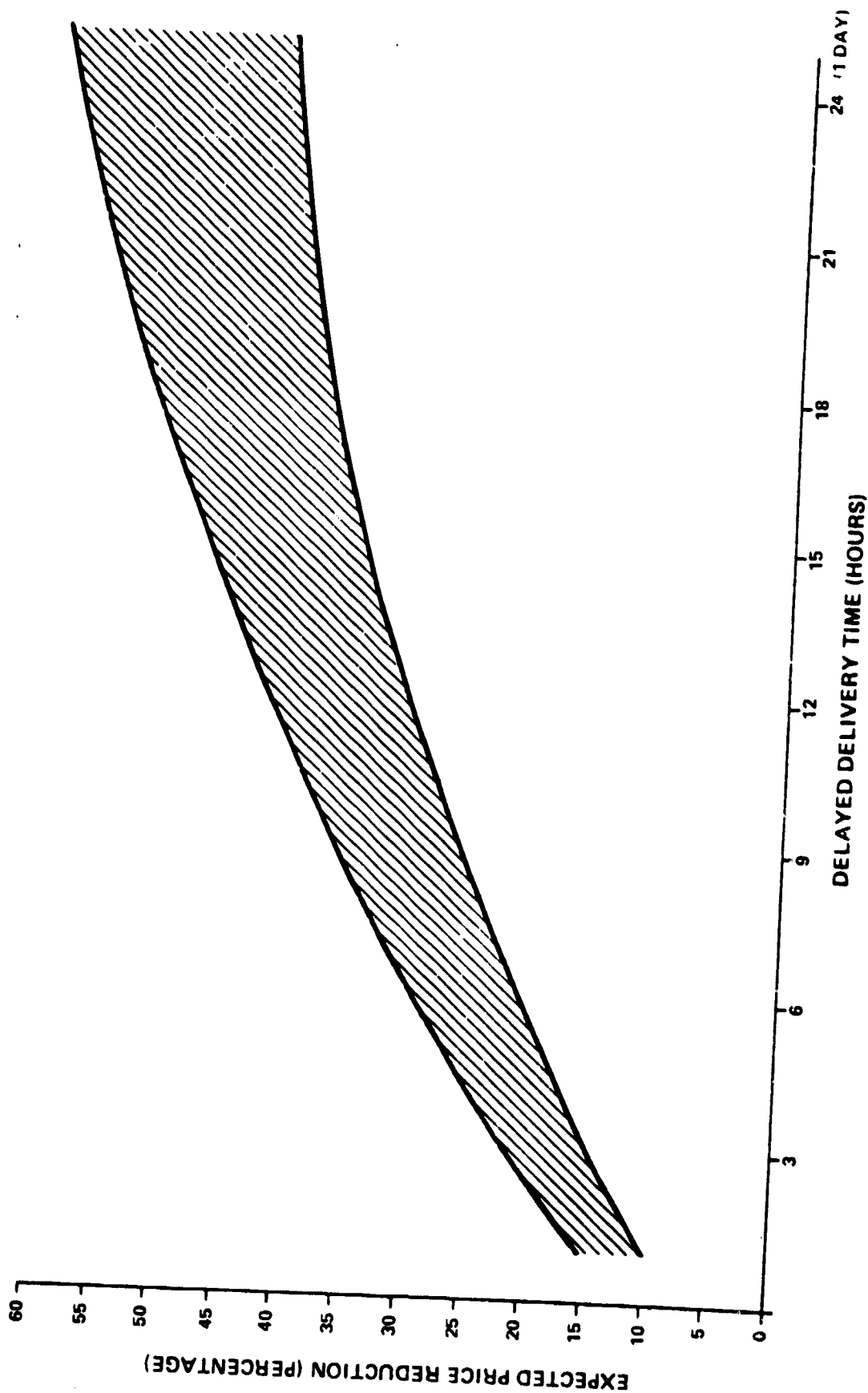
## F.2 Price Relationships: Reliability and Delivery Time

A series of user attitude models were created to estimate the price relationships of communications service with varying reliability levels and delivery times. A high correlation was found to exist between the level of reliability and immediacy of delivery on one hand, and the price users expected to pay for service.

The user attitude models were helpful in examining delayed delivery, where similar user expected price reductions were developed over a range of delivery times. Delayed delivery was examined over a time range of 1 to 24 hours. Beginning with a delay of 1 hour in message delivery, a correspondingly increasing price reduction was expected by users until at the end of 1 day's delay a 40-60% reduction in price was expected (Figure 9).

## F.3 Price Elasticity

Elasticity of demand is a means of measuring the sensitivity of traffic volume to a change in service price. Limited available source material



**PRICE CHANGE AS A FUNCTION OF NON REAL-TIME DELIVERY**  
(LOW RELIABILITY DEMAND)

FIGURE 9

was used to estimate price elasticity relationships for telephone service, Telex/TWX services, Telegraph services and digital data services. Supporting tariff material filed with the FCC provided the major source of data. The price elasticity of specific communications services could not be projected in the future due to lack of source material on future trends.

#### F.4 Satellite Service Cost Analysis

Analysis was made of the present and projected costs for terrestrial end links from the earth station to the switching center and end-to-end satellite system services.

The terrestrial end link cost analysis examined three competing systems: digital microwave, coaxial cable and fiber optic cable. Each digital transmission system cost was compared on an annual cost per mile basis.

The analysis indicates that rapid decline is anticipated in fiber optic costs. Digital microwave and optical cable are presently about equal on a cost per mile basis and are both expected to decline rapidly over time to a level around \$7 per circuit mile.

The satellite system cost analysis involved development of a parametric model of C and Ku-band systems containing multiple configurations and alternatives. Four service categories: voice, low speed, medium speed and high speed data, were analyzed on the basis of their annual cost per circuit over the twenty year period.

A comparison of satellite service costs for the lowest C and Ku-band alternatives was made with projected terrestrial rates to determine a crossover distance in miles. Representative cost crossovers projected in 1980 for voice and medium speed data are shown in Figure 10.

Satellite costs are projected to decline on a per channel basis as a function of increasing system fill levels and the introduction of new space and ground segment technologies.

#### G. SATELLITE MARKET DEMAND FORECASTS

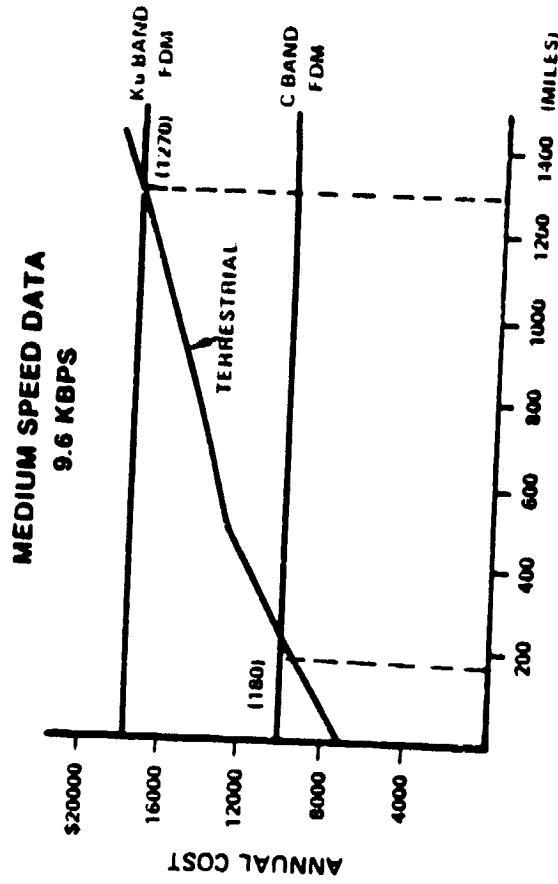
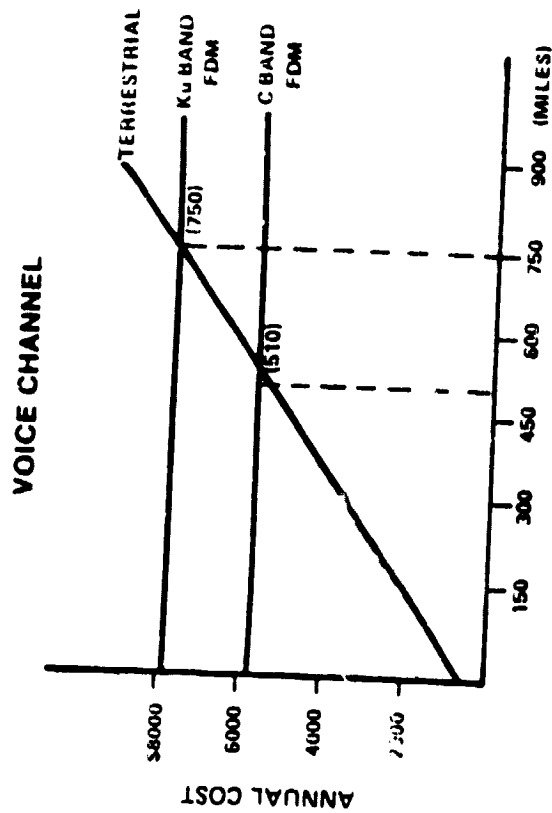
Identification of satellite market demand was accomplished via a two step process:

- segregation of the addressable satellite market from the total long haul traffic
- quantification of market demand appropriate to C and Ku-band, and 18/30 GHz satellite systems.

##### G.1 Segregation of Terrestrial and Satellite Traffic

The segregation of the net addressable satellite market demand from the total long haul traffic was accomplished by applying three general sets of criteria to each of the 31 applications.





**SATELLITE SERVICE CROSSOVER POINTS  
(LOWEST COST ALTERNATIVE FOR C AND Ku BAND)  
1980**

FIGURE 10

The first criteria were user/usage characteristics as related to specific applications, such as joint use of facilities for voice/data. The criteria were translated into portions of traffic not suitable for satellite transmission. The second set of criteria evaluated technical characteristics of either the satellite system or its operation such as satellite time delay, consideration. Traffic demand which could not be satisfied with the technical characteristics was considered unsuitable for satellite systems. The third criteria applied the terrestrial cost crossover previously determined for each service. Traffic of a distance shorter than the economic crossover was also excluded from the addressable satellite market.

The results of this screening process identified a significant market demand addressable by satellite, shown in Table 7.

Table 7 - Net Addressable (C-Band) Satellite Market Demand

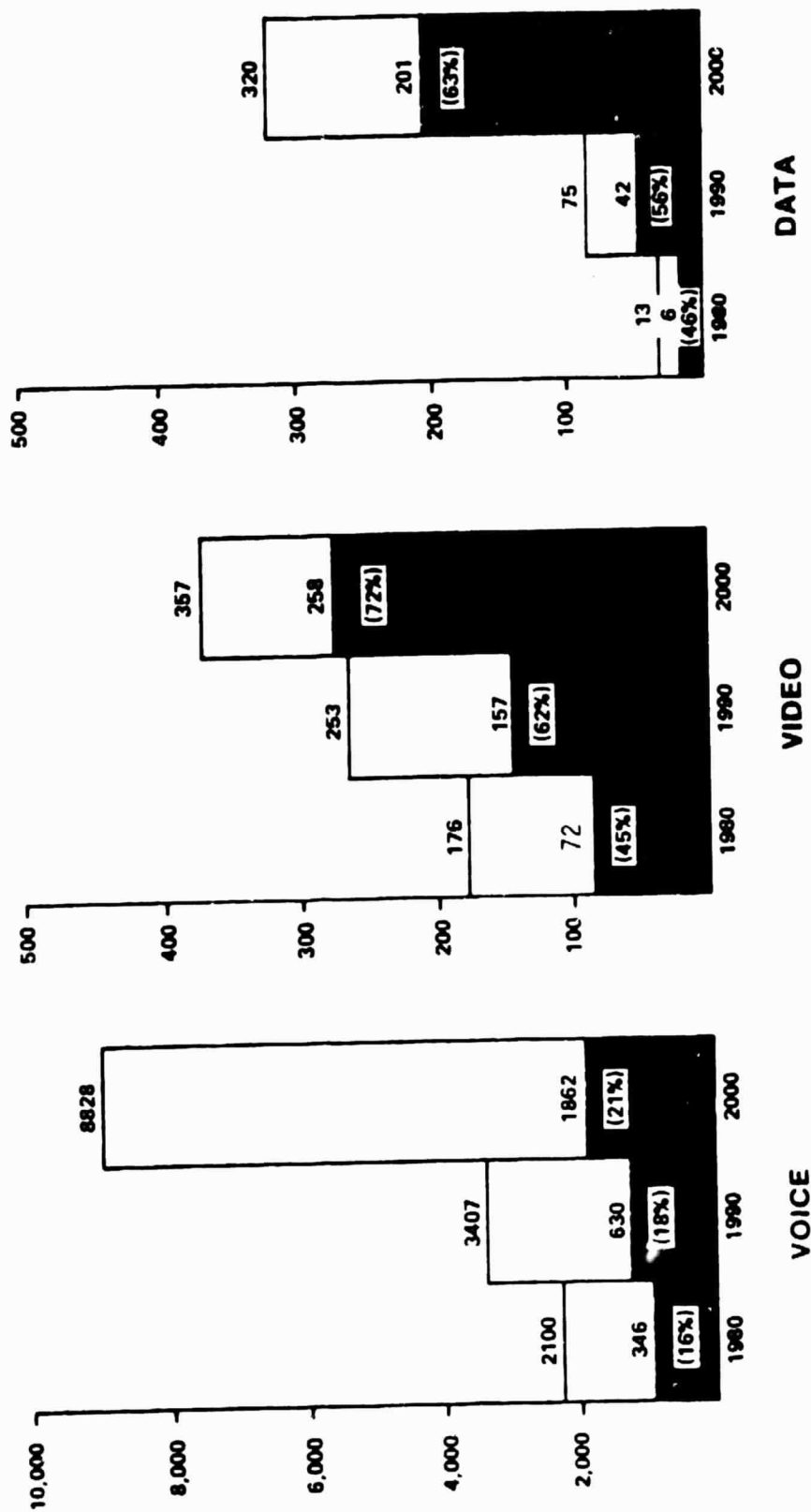
<u>Service</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>
Voice (Net long haul circuits x 1000) % of net long haul	345 (16%)	982 (18%)	2905 (21%)
Video (Net long haul channels) % of net long haul	79 (45%)	187 (62%)	340 (72%)
Data (Terabits/year) % of net long haul	464 (43%)	3215 (46%)	14553 (53%)

Voice continues to dominate the addressable satellite market demand in terms of traffic volume. Satellite data services are projected to grow at an average rate of almost 19% per year through year 2000.

Converting the above demand to equivalent transponders presents different satellite system availability of the net long haul traffic (Figure 11). Video and data services are projected to have vastly greater amounts of traffic addressable by satellite systems over the 1980-2000 time frame.

## G.2 Separation of C and Ku-Band Satellite Demand

The separation of Ku-band satellite demand involved evaluating a number of criteria previously used for C band demand forecasts. Applying these criteria, including the cost crossover calculations, to each service resulted in the net addressable Ku-band satellite demand, shown in Table 8.



**PROPORTIONS OF NET LONG HAUL TRAFFIC  
ADDRESSABLE BY C-BAND SATELLITE SYSTEMS**  
(EQUIVALENT TRANSPONDERS)

FIGURE 11

Table 8 - Net Addressable Ku-Band Satellite Market Demand

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>20 Year AAGR</u>
Voice (Half circuits x 1000)	142	372	1133	10.9%
Video (Wideband Channels)	30	93	214	10.3%
Data (Terabits/Year)	249	2045	8980	19.6%

G.3 18/30 GHz Satellite Market Demand

The final market area concerning the identification of the potential 18/30 GHz satellite demand was accomplished via the creation and evaluation of three market scenarios concerning system quality and service price levels. In Scenario 1, service price and quality were assumed to be equal to Ku-band systems. Scenario 2 was distinguished by an unchanged price but lower service quality. Scenario 3 reduced the price by 30% and had the same lower service quality as in Scenario 2.

Evaluations and trends previously established for C and Ku band forecasts were reevaluated for 18/30 GHz. Forecasts for 18/30 GHz traffic first expressed in the unique service units (i.e., terabits) were subsequently converted to equivalent transponders. For this study, an equivalent transponder has been equated to a net usable data rate of 50 Mbps for years 1990 and 2000. Thus an equivalent transponder can carry a maximum of 1560 half voice circuits, each operating at 32 Kbps. Results of this conversion of the net addressable satellite market to equivalent transponders is displayed in Table 9.

Table 9 - Net Addressable Satellite Market  
(Equivalent Transponders)

<u>1990</u>				
<u>Service Category</u>	<u>C-Band</u>	<u>Ku-Band &amp; 18/30 GHz (Scenario 1)</u>	<u>18/30 GHz (Scenario 2)</u>	<u>18/30 GHz (Scenario 3)</u>
Voice	630	239	138	252
Video	157	70	25	27
Data	<u>42</u>	<u>19</u>	<u>14</u>	<u>27</u>
Total	829	328	177	306
<u>2000</u>				
<u>Service Category</u>	<u>C-Band</u>	<u>Ku-Band &amp; 18/30 GHz (Scenario 1)</u>	<u>18/30 GHz (Scenario 2)</u>	<u>18/30 GHz (Scenario 3)</u>
Voice	1862	727	448	777
Video	258	147	70	75
Data	<u>201</u>	<u>93</u>	<u>72</u>	<u>135</u>
Total	2321	967	590	987

Analysis of the addressable 18/30 GHz market demand indicates that private line voice will dominate the addressable market (67% of total), and video-conferencing will also be a significant 18/30 GHz service application (9%) by year 2000. The significant increase in addressable market demand under Scenario 3 is due to the 30% price advantage which adds more than two thirds to Scenario 2 demand.

#### H. C AND KU BAND SATELLITE SATURATION

The net addressable satellite market is expanding at a rate where sometime over the next two decades the available C and Ku-band satellite systems capacity will be totally saturated. A hypothetical case is shown in Figure 12 and indicates a saturation somewhere in the 1990-1995 time period. However, many factors can impact this saturation point to delay its occurrence. Regardless of the year, the need for 18/30 GHz satellite systems may come about as a result of the growing implementation of long haul traffic demand by satellite systems.

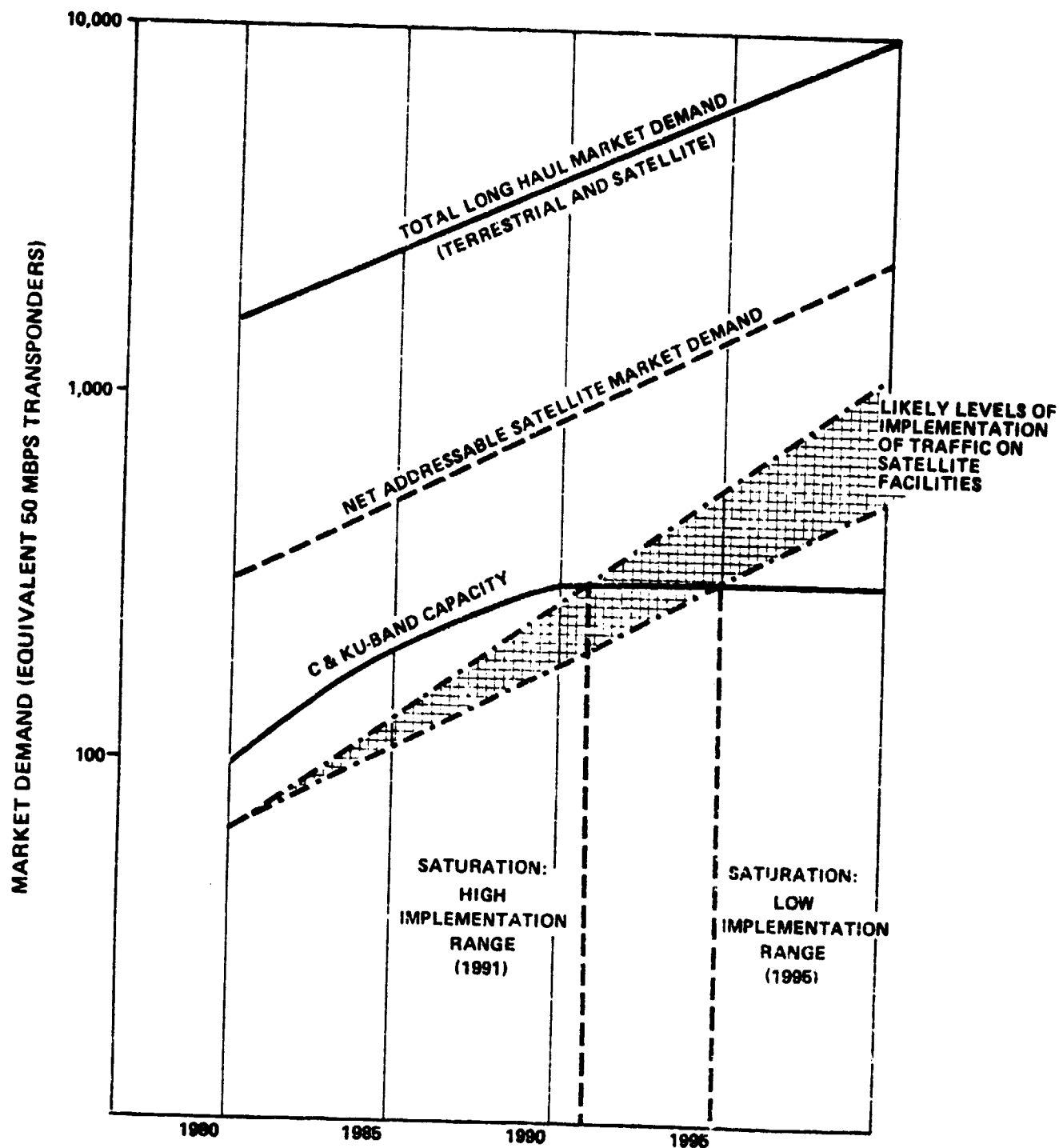
### III GENERAL STUDY OBSERVATIONS

A. The overall market demand for telecommunications services is expected to have a higher growth rate than most American business. The fastest growing communications service category is data, with electronic mail and data transmission applications showing the highest growth rates. Video teleconferencing is also projected to become a significant portion of the demand for video services by the year 2000.

Concentrations of traffic which exist today in large, north eastern corridor cities are expected to be less concentrated in year 2000 as population and business shifts become more pronounced in the Southern cities of this country.

B. The analyses of users demand for telecommunications indicated that:

- Users often were not able to identify and define their short and long haul demand by service applications. While this is an important element for a communications manager's planning of telecommunications services and facilities, distance separation of the demand for this study required considerable analysis of user operating characteristics.
- The State and Local government units are departmentalized and lack centralized control over their telecommunications requirements and costs. Therefore, this group will be slower in taking advantage of benefits derived from innovative services introduced in the 1980's and 1990's.
- Geographical distributions of each user's video demand were not developed. Aggregate video demand can be quantified using geographically based indicators, however, these are not available on a user category basis.



**C & Ku-BAND SATELLITE SATURATION  
ESTIMATED YEARS OF OCCURRENCE**

C. Most users participating in the metropolitan area survey were unable to project their telecommunications requirements, services or volumes, beyond the mid-1980's. Other indicators were used to estimate demand in later periods.

The selection of Phoenix as a representative city was demonstrated to be a valid and appropriate choice for a city of its approximate size. However, it is recognized that no one city can be representative of all cities because of their distinctive sizes, locations and demographics.

D. The parametric cost models indicate that the improving cost advantages of satellite transmission are dependent on system fill levels achieved. In effect, as system fill increases, cost advantages for satellite improve, thus increasing system fill further.

The multiplexing approach used in a satellite system affects service cost per circuit. TDMA appears to be an efficient mode for data services while Frequency Division Multiplexing has cost advantages for voice services.

E. An increasing proportion of the total traffic in excess of 40 miles will be suitable for satellite transmission. Especially significant increases in service penetration by satellite systems is projected to occur for video and data services. Voice traffic will continue over the twenty year period to dominate the total addressable satellite market. Specific high penetration of satellite services will include private line voice and video teleconferencing, both of which will be suitable for 18/30 GHz systems.

It is possible that 18/30 GHz satellite systems can generate a significant addressable market given a favorable price advantage and slightly lower reliability compared to Ku-band satellite systems.

#### IV STUDY RESULT CONSIDERATIONS

Several areas of consideration arose from the final results of this study:

- a. The distribution of nationwide traffic varies widely; this indicates a need for a satellite system that provides flexible allocation of bandwidth based on geographical demand rather than a fixed beam capacity.
- b. No determination was made in the market study as to the "ideal" or appropriate number of cities to be served via 18/30 GHz. However this will be a function of:
  - the available beam coverage, i.e., beam widths
  - bandwidth allocation arrangements

- heavy route concentrations and configurations
- type of services to be provided, i.e., voice, video, and data
- c. Due to the undeterminability of satellite traffic market shares and the number of carriers vying for that market in the future, all satellite service forecasts have been identified as net addressable market demand. This is defined as demand which could be suitably served by satellite systems in the C, Ku or millimeter wave bands.

The limitations imposed by using net addressable market are that:

- there is overlapping demand which exists among all three satellite frequencies, making the forecasts non-additive;
- traffic which is "suitable" is not necessarily the same as traffic actually carried on a specific satellite system;
- the geographic coverage implied in the forecast is for all 275 Standard Metropolitan Statistical Areas (SMSA), which may not be the coverage of an actual system.
- d. Due to the above limitation, it seems that the potential 18/30 GHz system size requirements may only be determined by examining a number of market scenarios. These scenarios would deal with variations in service price, reliability, common versus trunking networks and most efficient network size.

## V

### REPORT ORGANIZATION

The Final Report has been divided into three volumes in order to provide different levels of detail to the reader. Volume 1 is an executive summary giving major study objectives, overall methodology, summary of results and general observations about the satellite systems market characteristics and trends.

Volume 2 contains the essence of the study with in-depth summaries of the analytical aspects included. Very detailed forecasts, computer tabulations and research material can be found in Volume 3, the Appendix.

Volume 2 contains seven sections, the first being an introduction to the volume and brief summary of results. The remaining sections are separately devoted to each of the tasks contained in the NASA Statement of Work.

Section 1	Literature Survey
Section 2	Telecommunications Service Demand
Section 3	User Market Identification
Section 4	Metropolitan Area Study
Section 5	Parametric Cost Analysis, Separation of Terrestrial/Satellite Traffic
Section 6	18/30 GHz Satellite Service Demand Forecast